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# DATABASE SYSTEM FOR NAVIGATION DEVICE

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## PRIORITY CLAIM

**[001]** This application claims the benefit of European Patent Application No. EP 03008092.3, filed April 15, 2003, which is hereby incorporated by reference herein in its entirety.

## BACKGROUND OF THE INVENTION

### 1. Technical Field.

**[002]** This application relates to a system and method for the efficient and cost-effective storage and utilization of database information provided to a navigation device. In particular, this application relates to a system and method for the storage and utilization of geographic data for use in a GPS navigation device, in particular a vehicular GPS navigation device.

### 2. Related Art.

**[003]** Computer-based navigation systems are available that provide end-users (such as operators of vehicles, for example, automobiles, trucks, marine vehicles, airplanes, helicopters, and other types vehicles, in which the navigation systems have been installed) with various navigating functions and features. For example, some navigation systems may determine an optimum route of travel between two locations. In such a navigation system, a current position of a vehicle is detected by equipment that is capable of determining the vehicle's physical location, such as equipment utilizing a global positioning system (GPS). A navigation application program then may assess the various alternative routes between the two locations available to the operator and determine the optimum route. The system also may identify and provide the user with other information such as instructions for the route

and the manoeuvres that may be required to execute the route. In one example of a navigational system, road map data and information relating to a road map data are obtained from a storage medium, for example, a compact disc or DVD mounted on the navigation device. The desired route from the current vehicle position to the desired destination point input by a user is determined, and the vehicle is guided from the current location along the determined route to the destination by using picture and voice.

**[004]** Known navigation systems contain street data relating to the geometrical aspects of the street, for example, the position, the length, the geographical altitude, and the direction of the street. Using this street information data, a map can be built and presented on a display unit. Terms, present, presentation and presented are not limited to visual presentation, but are intended to encompass all means of presentation of data such as, for example, audio, visual, and combined audio and visual. The geometrical street data are normally stored as vectors indicating the length and the direction of the street. Various terminologies for describing the aspects of street information, and these other terminologies are intended to be encompassed within the scope of these concepts.

**[005]** In addition to street information, navigation systems may comprise additional data containing location information. The location information data may include the name of the streets, classification of the streets, the type of street, for example a highway or a pedestrian zone, as well as other information. This location information data may also include information regarding hotels, gas stations, restaurants, landmarks, points of interest or any other information that may be helpful for the user of the navigation device.

**[006]** Generally, navigation systems may receive and store the location information data together with the street information data, and thus, the data containing location information may be linked to the street data. If the data needed to present a certain region of a map is loaded into the data buffer of the navigation system, the whole data including street data together with a link to the other data containing location information is loaded. Where the data needed to present a certain region of a map is large, there may be insufficient space in the navigation system buffer to store and provide all of the street as well as the desired location information. Additionally, the storing of these data is highly complex and very time-consuming, requiring a large memory space to store the complete data.

**[007]** Electronic travel guides are known in which additional location information data, for example, data of famous monuments, buildings, towns, or villages are stored on an electronic medium, such as a CD, together with their geographical position data. In known navigation systems, the information stored in these electronic travel guides may be loaded into the working memory of the navigation device and presented, for example, on a display of the navigation device. If, however, the navigation device is used to navigate the user to a certain destination, the whole working memory space may be filled with the map data needed to indicate the itinerary to the chosen destination. In such a situation, the user of the navigation device wants to have additional information from the electronic travel guide, this travel guide cannot be used simultaneously with the operating mode of the navigation device, for example, for navigating the vehicle. Thus, when the additional location information stored on the electronic storage medium of the travel guide is to be presented, this information of the electronic travel guide has to be loaded into the working memory of the navigation device and all or part of the information comprising the map data must be cleared from the working memory to make room for the location information. In conventional systems, switching between the two operation modes without clearing some of the memory in use for the navigation function is very difficult if not impossible. Therefore, there is a need for a navigation system which enables flexible presentation of street and location information.

**[008]** Location information and street information typically are stored together in a single database. If a user desires updated location information, he may be required to purchase updated street information as well as the updated location information, thereby increasing his costs. Thus there is a need for a navigation system that enables cost-effective updates to the system.

## SUMMARY

**[009]** The invention provides a database system for a navigation device and, in particular, a database system for a global positioning (GPS) vehicular navigation device having a first database comprising street (map) information data and a second database comprising location information data. The street information data in the first database may be independent of the location information data in the second database. For example, the street information data and the location information data may not be linked, *i.e*, the data of one type does not point to

the data of the other type, although the data may be contained on the same storage medium. Thus, the location information data from the second database may be supplied independently of the street information data to the working memory of the navigation device, and the location information data may be used at the same time the street information is being used, without accessing or overwriting the street information. Further, the location information data may be updated without updating the street information data. Additionally, the two data may be processed separately by the processing unit.

**[010]** A database system is provided for a global positioning system (GPS) vehicular navigation device having a first database comprising street information data; a second database comprising location information data, with the street information data being independent of the location information data; a working memory unit comprising a first memory area and a second memory area separate from the first memory area, where at least a portion of the street information is stored in the first memory area and at least a portion of the location information is stored in the second memory area. The memory areas may be dedicated memory areas to each of their respective first and second data.

**[011]** A third database comprising blocks of data sets that relate to the geographical position data of the second database may be provided. Each block may comprise an index relating to the geographical information of the data sets of the block. The third database may facilitate the search of data relating to location information of a specific geographical location.

**[012]** In addition, a method for providing information to a navigation device is provided, comprising storing street information data in a first database; storing location information data which is independent of the street information data, in a second database; providing at least a portion of the street information data to a first memory area of a working memory unit associated with the navigation device; providing at least a portion of the location information data to a second memory area of the memory unit; processing either or both the portions of the street information data and the location information data; and providing the processed information to the navigation device.

**[013]** The system also may include a method for operating a navigation device in a vehicle comprising detecting a GPS signal identifying the location of the vehicle; retrieving street information data from a first database; supplying at least a portion of the street information data to a first memory area of a working memory unit; retrieving location information data from a second database independent of the first database; supplying at least a portion of the

location information data to a second memory area of a working memory unit; processing the portions of the street information data and location information data, providing the processed data to the navigation device, and presenting the processed data.

**[014]** Other systems, methods, features and advantages of the invention will be, or will become, apparent to one with skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description, be within the scope of the invention, and be protected by the following claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[015]** The invention can be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like referenced numerals designate corresponding parts throughout the different views.

**[016]** Fig. 1 is schematic view of a database system for a navigation device.

**[017]** Figure 2 is a schematic view of a database system for a navigation device.

**[018]** Figure 3 is a flow chart showing a method for providing information to a navigation device.

**[019]** Figure 4 is a flow chart showing a method for providing location information from a second database to a navigation device.

**[020]** Figure 5 is a flow chart showing a method for providing safety information to a navigation device.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[021]** This application relates to a system for the efficient and cost-effective storage and utilization of database information provided to a navigation device. In particular, this application relates to a system and method for the storage, utilization, and upgrading of geographic and other data for use in a Global Positioning System (GPS) navigation device, in particular a vehicular GPS navigation device.

**[022]** There is a need for a navigation system comprising a database system having a simple flexible structure where the street and location information in the navigation system are supplied to the system independently and stored separately in the navigation system. There is also a need for a navigation system where different databases available to the system can be used and updated independently of the other without the need to use or update the other databases. There is also a need for a navigation system where different types of data supplied to the navigation system can be used and presented simultaneously without one set of data overwriting the other.

**[023]** A database system for a navigation device and, in particular for GPS vehicular navigation device for providing street information and location information to the navigation device is shown in Figures 1 and 2. The database system **10** for a navigation device may have at least a first database **20** and a second database **50**. The first database **20** may comprise street (map) information data. The first database **20** may contain additional information or may only contain street information data. The second database **50** may comprise additional information or only location information. The location information data may be independent of the street information data. By "independent" it is meant that the first and second data are not dependent on one another to access, interpret, process or use information in the databases. In this manner, the second data **51** may be used without using the first data **21**, and vice versa. The data of the first and second databases may be physically and logically separate from one another and the data from the respective databases may be independently supplied to the database system of the navigation device and used independently. The storage capacity needed, therefore, for each database may be reduced.

**[024]** As shown in Figures 1 and 2, database system **10** is also provided for a GPS vehicular navigation device having a first database **20** comprising street information data; a second database **50**, comprising location information data which is independent of the street information data; a working memory unit **33** comprising a first memory area **31** and a second memory area **32** separate from the first memory area, where the first data **21** comprising street information is stored in the first memory area **31** and the second data **51** comprising location information is stored in the second dedicated memory area **32**. The global positioning navigation device comprises a GPS receiver **70** for determining the location of the vehicle. The GPS receiver **70** may be installed in a vehicle. The GPS receiver receives

the signals emitted from the GPS satellites in space and an exact position of the vehicle is determined. The GPS signal received by the navigation device **10** may be compared to the geographical position data **53** of the second database **50**. The navigation device **10** may also comprise an input/output unit **41** and a transmitter/receiver unit **75** for wireless communication to the first and/or second databases.

**[025]** In Figure 1, a navigation device **10** comprises a first database **20** containing first data **21** comprising street information data. "Street information" may be any data that pertains to the geometrical aspects of a street or roadway network, including, though not limited to, the position of the street (latitude and longitude), the length of the street, the geographical altitude of the street, the direction of the street, roadway intersections and other aspects. These aspects may be used to compile a map that may be presented to a user, such as visually displayed by the navigational system on, for example, a monitor associated with the navigational system. In Figure 1, control unit **30** provides a display device **40** with data **21** from the first database **20** to present a street map for a particular area.

**[026]** First database **20** may contain the street information as vectors indicating the direction and the length of the street. The first database **20** may comprise any data compilation, including a file and may be stored in a first storage unit and the second database **50** may comprise another data compilation, including a file, and may be stored in a second storage unit, as shown in Figure 1. Or, the first and second databases may be stored in a single file, segmented from one another. The first and second databases may be stored on CD-ROMS, PCMCIA cards, fixed or hard disks, DVDs, or other currently available storage media, as well as storage media that may be developed in the future. For example, the first database **20** may be stored on one CD-ROM and the second database **50** stored on a second CD-ROM. Alternatively, both databases may be stored in separate areas of the same CD-ROM. The databases do not have to be physically provided at the location of the navigation system. One or both of the databases may be located remotely from the rest of the navigation system and provided via a communications link. For example, the second data **51** may be stored on a separate storage unit comprising a server that is remote from the navigation device and provides the second data to the navigation device via a mobile communication link. Additional location data transmitted to the second database can be saved in RAM, Flash Memory, on a hard disk or other device after the data has been downloaded to the navigation device.

**[027]** The second database **50**, comprising second data **51**, may include location information. "Location information" may be any data relating to a particular location on a map including, though not limited to, road related data, for example the name of the street, the legal direction of the street, governmental or other classification of the street, the type of roadway, speed limitations, directional signage, vehicle weight limitations, and other vehicle restrictions. Road related location information may also include, in addition to information contained on street or highway signs, "virtual" street signs, such as weather related information that may be detected by sensors on the vehicle or obtained from some other source, curvature radii of the street, and other physical conditions or aspects of the street or location. Location information may also include information on special destinations or Points of Interest (POIs), for example gas stations, convenience stops, rest stops, museums, hotels, restaurants, monuments, hospitals, and the like. Generally location information changes more frequently than street information. In conventional systems, the updating of location information generally also requires the simultaneous purchase of street information, which may or may not have changed and require updating.

**[028]** The second database **50** may contain geographical position data **53**, and the location information of the second database **50** may be arranged according to the geographical positioning data **53**. Additionally, the location information may be stored in datasets **54** that are arranged on the second database **50** according to the geographical position data **53**. The location information data, along with geographical position data **53** meeting a predetermined requirement, may be supplied to the navigation system for processing. Predetermined requirements may include a predetermined location on a map, a predetermined itinerary to a predetermined destination, location information from one reference point to the next, all geographical position data within a predetermined distance to a reference point, and the like. The reference point may correspond to the geographical position of a vehicle having a navigation device or a destination input by the user. All location information data meeting a predetermined requirement may then be supplied to navigation apparatus and transmitted to the user. A search unit **42** may be used to locate all location information meeting the predetermined requirement. For example, a search may be made of all of the location information data for an area between one reference point and another. Once the search for this information of the second database is completed, the information is supplied to the

navigation device. The search may be facilitated by a third database **60** comprising blocks **61** relating to the geographical position data of the second database and an index.

**[029]** Location information meeting a predetermined requirement may be presented on a display device of the navigation apparatus or may be announced by voice. Location information also may be presented by a video on a display. Additionally, the first data **21** stored in the first database **20** and the second data **51** stored in the second database **50** may be processed and presented together on a display unit **40** by any means known to one skilled in the art. For example, the processor may process the street information as one task and the location information as another task, and then feed both to a common display task. Hence, the display unit **40** of the navigation system may provide street information and location information at the same time. For example, the presentation may be in the format of a split screen mode where the map or street information is displayed on one part of the screen and information relating to a particular point of interest is displayed on another part of the screen.

**[030]** The second database **50** may communicate with a control unit of the database system by wireless communication. For example, the second database **50** containing the location information can be part of a server which is accessible with a TCP/IP protocol by using the worldwide web, thus permitting the more frequent updating of the location information data independent of the street information data. Data transmission between the navigation device and the second database may also be accomplished by using infrared, bluetooth, wireless LAN, GSM, GPRS and/or UMTS or any other technology suitable for transmitting these data.

**[031]** The street information data and location information data may be provided independently of one other, such as in separate databases. Additionally, the street information data and the location information data may be independently supplied to the navigation device and stored separately in the navigation device in memory areas dedicated to the type of information. Because the street information data and the location information data may be provided and stored independently, there is increased flexibility in the handling of the data. For example, the location information may be used without using the street information. Moreover, both sets of data may be supplied to and presented by the navigation system, simultaneously and independently of one another. This allows the volatile or working memory **33** of the navigation system **10** to be more efficiently and effectively utilized. In addition, the location information data may be updated more easily and

efficiently since the street information and location information are independent of one another. Thus, updates to location information data can be separately and more inexpensively acquired.

**[032]** The second database **50** also may include different data fields **52**. In at least one data field, geographical position data **53** are stored. The geographical position data **53** and the data fields **52** may be used to build data sets **54**. Each data set **54** may be stored in the second database **50** according to its geographic position x and y. In this way the arrangement of the datasets **54** in the second database **50** corresponds to the geographical position data **51**. Thus, the second database may be built by ranking the different data sets according to the global position ranking from the global positioning data. In the other data fields **52**, location information for the geographical position x,y may be stored. As referred to previously, this information may be any data relating to a particular location on a map including, though not limited to, road related data, for example the name of the street, the legal direction of the street, governmental or other classification of the street, the type of roadway, speed limitations, directional signage, vehicle weight limitations, and other vehicle restrictions. Road related location information may also include, in addition to information contained on street or highway signs, "virtual" street signs, such as weather related information that may be detected by sensors on the vehicle or obtained from some other source, curvature radii of the street, and other physical conditions or aspects of the street or location. The location information stored in each dataset **54** may also include points of interest (POI) in which any information available relating to such things as restaurants, hotels, and the like, can be stored. In addition to the geographical position data **53**, datasets **54** may also include direction information, speed limitations or positions where radar speed checks are made.

**[033]** As shown in Figure 1, to facilitate locating certain geographical position data, a third database **60** may be provided. The third database **60** may include different blocks **61** that relate to the geographical position data of the second database **50**. Each block **61** may also include the geographical position data **53** of at least one data set **54**. Each block **61** may also comprise an index to the geographical information of the datasets **54** contained in the block **61**. The third database **60** may facilitate the search of data relating to location information of a specific geographical location. The third database **60** may be stored in a separate storage unit from the first and second databases. Alternatively, the third database may stored in the storage unit of either the first or second database.

**[034]** The navigation system **10** may further comprise a GPS receiver **70** for receiving a GPS signal emitted by GPS satellites. The GPS receiver **70** receives the emitted signal and determines the exact position of the navigation system **10**, normally present in a vehicle. Though other navigational systems such as hand-held systems are also contemplated. If determining location of a navigation device by GPS is not possible or is faulty, for example when not enough GPS satellites are detected by the GPS receiver, the location of the navigational device can be determined by "dead reckoning." In this instance, other signals may be utilized to determine the location of the navigational system, for example, signals from gyromagnetic devices, information from wheel sensors, and information from map matching.

**[035]** The database system **10** also may include a working memory unit **33** with a first memory area **31** for storing the first data **21** and a second memory area **32** for storing the second data **51**. The working memory unit **33** may be a random access memory (RAM) or other volatile memory of the navigation device. The working memory unit **33** may be divided into at least two separate and discrete areas, each area being "reserved" for or "dedicated" to the first data **21** and for the second data **51**. "Dedicated" means that the first memory area **31** receives and stores first data **21** from the first database **20** and the second memory area **32** receives and stores second data **51** from the second database **50**. Although the data may be independent of one another, the data of the first and second databases may contain some of the same information. For example, certain first database data that may be required to compile the map may include the street name. The street name may be also included in the location information.

**[036]** By providing dedicated memory areas in the working memory unit, the first data containing street information and the second data containing location information may be accessed and used simultaneously, without the need to switch from an operation mode in which the navigation device is directing the vehicle, to a different mode to obtain location information. Thus, the processing unit can process these two data at the same time and supply the two data to the navigation device for presentation without the need to clear the memory area of the working memory unit before loading further data. Consequently, both the first and second data may be processed and presented at the same time, without the need to remove or overwrite data in the memory area. Thus, the operator of the navigation system may use the navigation mode of the navigation device while at the same time access desired

location information, because the processing unit separately and independently accesses and processes the separate data in the respective memory areas.

**[037]** During use, the first data **21** of the first database **20** are provided to first memory area **31** of the working memory unit **33.** The second data **51** of the second database **50** are provided to a second memory area **32** of the working memory **33**. The navigation system may include a processing unit **35** for accessing and processing the first data **21** and the second data **51**. The processing unit **35** accesses the first and second data from the first and second databases and provides the data to their respective memory areas of the working memory of the navigation system. The processing unit **35** processes the data in the memory areas and provides the data to the navigation system **10** for presentation. The processing unit **35** may be of any type used in navigation systems, such as those known in the art and sold by, for example, Hitachi, Intel, and Motorola. The first data **31** and the second data **51** may be provided simultaneously to their respective memory areas in the working memory **33**, so that the data may be processed simultaneously and, subsequently, presented on the display device **40** of the navigation system **10** simultaneously. The components of the navigation system **10** communicate with each other via a bus system **36**.

**[038]** In Figure 2, navigation device **10** comprises control unit **30**, processing unit **35**, working memory unit **33**, with at least a first memory area **31** and a second memory area **32**, GPS receiver **70**, first storage unit **90** (which comprises first database **20**), second storage unit **80** (which comprises second database **50** and third database **60**). First storage unit **90** comprises first data containing at least street information. Second storage **80** unit comprises the second database **50** containing at least location information, and third database **60** containing blocks (as shown in Figure 1). Navigation device **10** may further comprise a display unit **40**, an input/output unit **41** and a search unit **42**.

**[039]** During use, a navigation device **10** having a GPS receiver **70** detects a GPS signal corresponding to the location of the navigation device, for example in a vehicle. First data **21** stored in a first database **20**, comprising street information, are supplied to a first memory area **31** of a working memory unit **33** of the navigation device **10**, such as the RAM of the device. Second data **51**, independent of the first data **21**, from a second database **50** comprising location information and its geographical position may be supplied to a second memory area **32** of the working memory unit **33** of the navigation device **10**. The first and second data are processed by a processing unit **35** and supplied to the navigation device **10**.

The second data **51** that are supplied may be that which meets a predetermined requirement, discussed previously. Thereafter, the position of a vehicle having the navigation device may be presented together with the corresponding location information data.

**[040]** In Figure 3, a method of operating a navigation system of the invention is illustrated. A GPS signal of a vehicle having a navigation system is detected (Step **100**) and the location of the vehicle is determined (Step **110**). First data stored in the first database are provided to the first memory area of a working memory unit of the navigation device, the data is processed and a street map is presented on the display unit (Step **120**). A predetermined requirement may be identified, for example, the user of the device desires to know all of the restaurants, hotels, or gas stations that are within a certain distance of a destination (Step **130**). The data meeting the predetermined requirement may then be chosen (Step **150**) from the second database. The first data and the second data that met the predetermined requirement are provided to the first memory area and second memory area, respectively, of the working memory unit. The processing unit accesses the first and second memory units, processes the data therein, and provides the processed data to the navigation device (Step **160**). The second data comprising the predetermined requirement can be presented on the display device of the navigation device together with the first data containing the street information.

**[041]** In Figure 4, after determining the location of the navigation device in the moving vehicle (Step **110**), a predetermined requirement may be determined (Step **130**). For example, the requirement may contain the information that as soon as the moving vehicle reaches a selected map area with a predetermined location, the search unit **42** searches in the second database **50** and/or in the second database **50** and the third database **60** for the predetermined location. For example, as soon as the vehicle arrives at or near the predetermined location, location information, such as information about a famous monument and its history, is provided. In addition, an ongoing circular search within a particular radius about the vehicle position to identify special points of interest may be performed. The circular search also may include a search for particular location information within an increasing radius, such as identification of the nearest three golf courses. The found data are provided to the second memory area of the working memory of the navigation device (Step **160**) and then presented by the navigation device (Step **170**). The presentation may comprise a video or voice

sequence informing the user of the vehicle of the chosen monument and/or may contain the distance of the monument from the actual location of the vehicle. At the same time, notwithstanding the presentation of this information, the first data containing the street map also may be presented. Additionally, the second data containing the location information may be integrated within the presentation of the street information.

**[042]** In Figure 5, the location of a moving vehicle is determined (Step **110**), and an area around the location of the vehicle may be determined, for example an area comprising a circle having a predetermined radius, the center of the circle being the position of the vehicle (Step **115**). The area around the location of the vehicle can be made dependent on the vehicle speed, for example, when the vehicle is at a higher speed the area chosen may be larger than that chosen at a lower speed. A search of the second database is performed, for example, the object of the search may be to find all of the safety information, such as speed limits, or any road related data such as curvature radii or road conditions in a given area (step **165**). The safety information is found and then presented by navigation device (Step **170**). In this example, during a journey, the navigation device receives the current position of the vehicle via GPS and may determine the type of road on which the vehicle is travelling. In addition, when the operator arrives at a certain geographical position, the navigation device can inform and remind the user of the safety information in the area, such as the speed limit and other safety information, for example, dangerous road conditions or bad weather conditions. The conditions may be transmitted to the navigation device via wireless communication or by other sensors of the vehicle. In this example, the second database comprising the second data containing this location safety information may be part of a remote server which provides the data.

**[043]** While various aspects of the invention have been described, it will be apparent to those of ordinary skill in the art that many more aspects and implementations are possible within the scope of the invention. Accordingly, the invention is not to be restricted except in light of the attached claims and their equivalents.